

BIOCHEMISTRY OF LIPIDS

Mutaz Amin

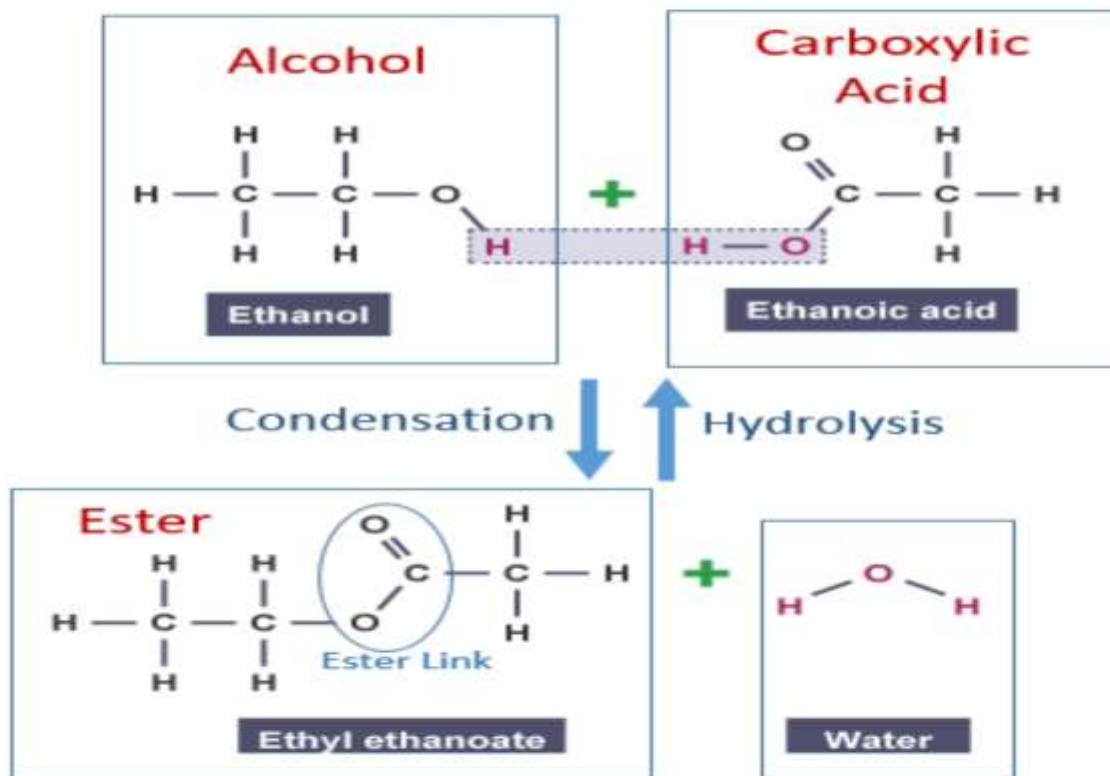
WHAT ARE LIPIDS?

- LIPID describes a chemically varied group of fatty substances and are highly concentrated energy stores.
- They are water-insoluble bio-molecules but soluble in organic solvents such as ether, benzene. Chloroform, etc.

- Lipids serve as fuel molecules, signal molecules, and components of membranes, hormones and intracellular messengers.
- They are esters of long chain fatty acids and alcohols.

Esterification

An alcohol reacts with a carboxylic acid in the presence of a catalyst (conc. H_2SO_4) to give an ester.



FUNCTIONS OF LIPIDS

- Lipids are the constituents of cell membrane and regulate membrane permeability.
- They protect internal organs, serve as insulating materials and give shape and smoothness to the body.
- They serve as a source of fat soluble vitamins.

- Essential fatty acids are useful for transport of cholesterol, formation of lipoproteins, etc.
- Cholesterol is a constituent of membrane structure and it synthesizes bile acids, hormones and vitamin D. It is the principal sterol of higher animals, abundant in nerve tissues and gallstones.

CLASSIFICATION OF LIPIDS

Based on there Biological functions Lipids can be classified into:

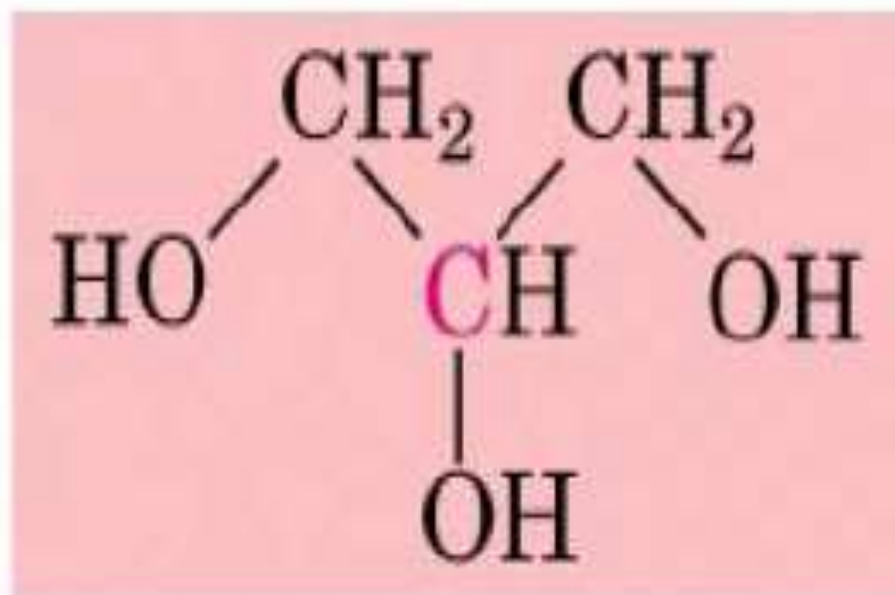
- ◉ Storage Lipids—The principle stored form of energy.
- ◉ Structural Lipids- The major structural elements of Biological Membranes

CLASSIFICATION OF LIPIDS

Lipids are broadly classified into simple lipids, complex lipids, derived lipids and miscellaneous lipids based on their chemical composition.

1. **SIMPLE LIPIDS:** These lipids are the esters of fatty acids with alcohols.
2. **COMPOUND/COMPLEX LIPIDS:** These lipids are esters of fatty acids with alcohols and additional groups such as phosphate, nitrogenous base, etc..

1. **DERIVED LIPIDS:** These lipids are obtained on hydrolysis of simple and complex lipids. These lipids contain glycerol and other alcohols..
2. **MISCELLANEOUS LIPIDS:** These include compounds, which contain characteristics of lipids. They include squalene, terpenes, hydrocarbons, carotenoids, etc.

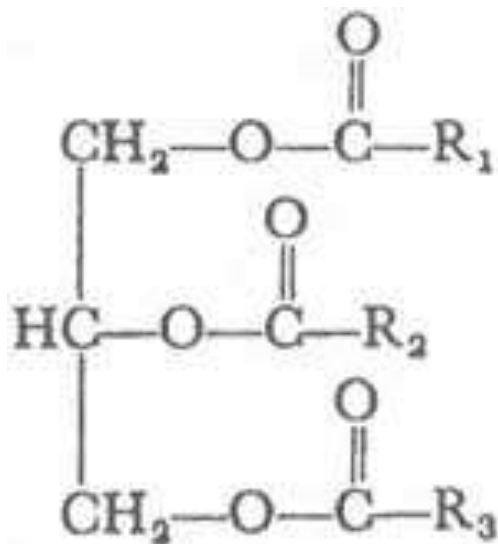


Glycerol

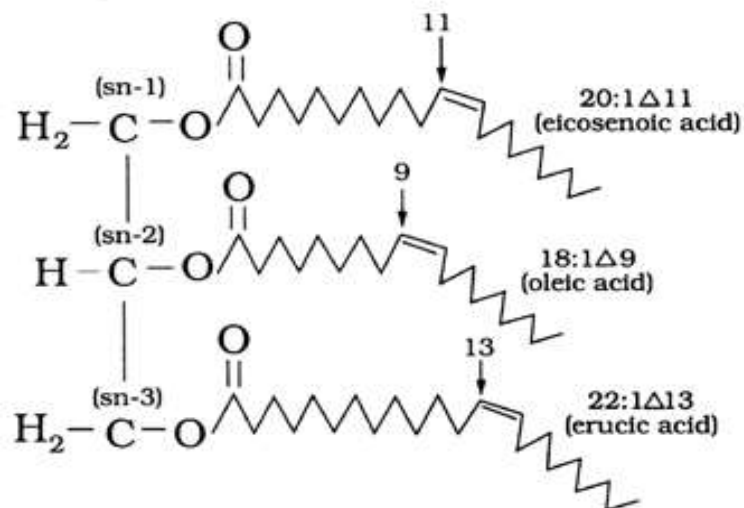
TRIACYLGLYCEROLS (TAG)

- Triacylglycerol(Triglyceride) is an ester of glycerol with three fatty acids.
- They are stored in adipocytes in animals.
- A mammal contains 5% to 25% or more of its body weight as lipids, 90%TAG

STRUCTURE OF TRIACYLGLYCEROL

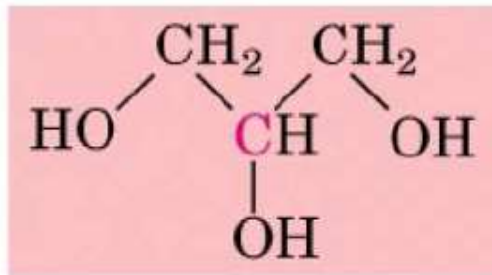


TRIACYLGLYCEROL

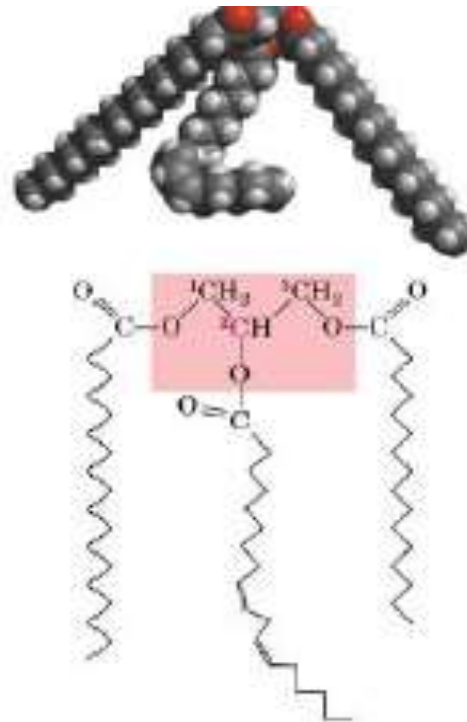


An example of TAG

FATS AND OILS



Glycerol



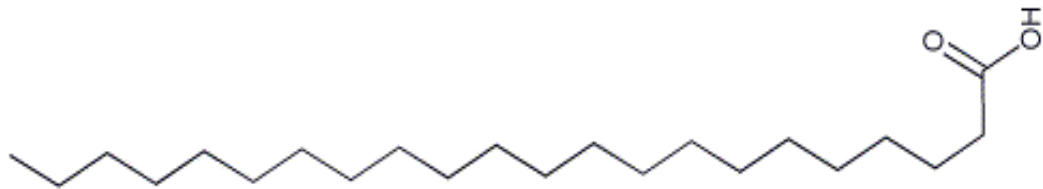
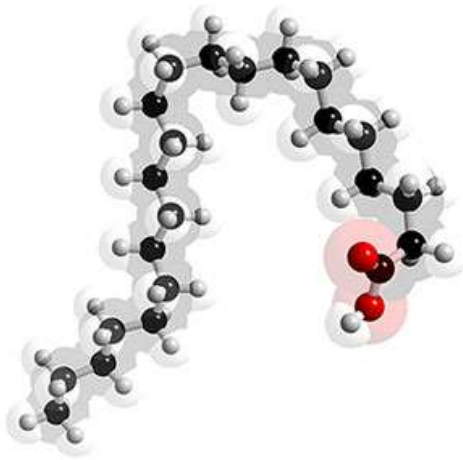
Most occurring TAGs are mixed, which contain two or more different fatty acids. TAGs are non polar, hydrophobic molecules, essentially insoluble in water

FATTY ACIDS

- Fatty Acids are carboxylic acids with hydrocarbon chains ranging from 4-36.
- Fatty acids are of 2 types: Saturated and Unsaturated.

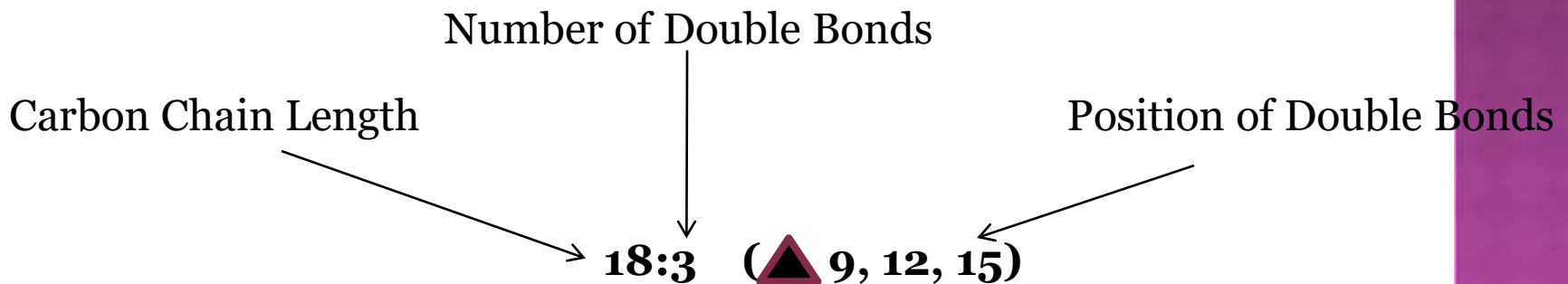
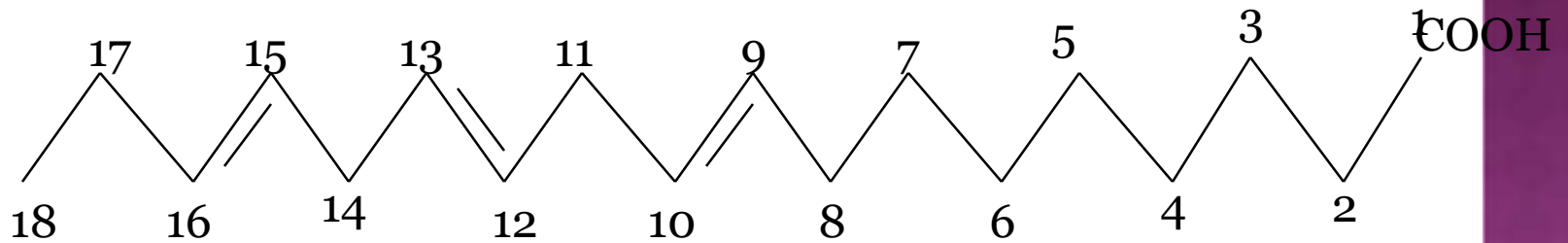
- Saturated Fatty Acids have no double bonds and thus the hydrocarbon chain is completely unbranched
- Polyunsaturated fatty acids have 2-6 double bonds.

SATURATED FATTY ACIDS



**Completely Unbranched and saturated
with no double bonds**

NOMENCLATURE OF FATTY ACIDS



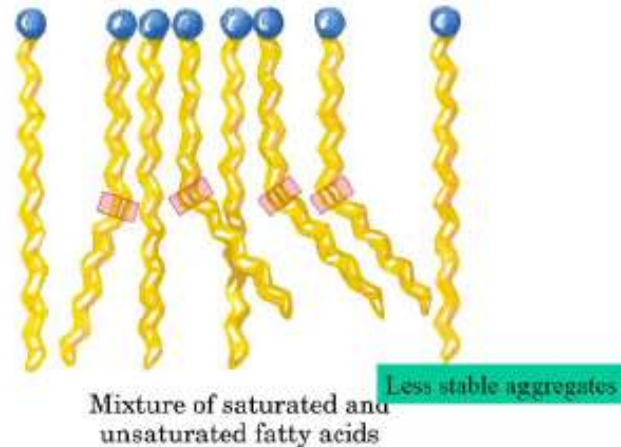
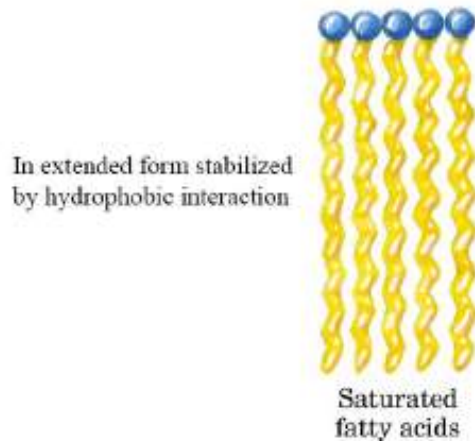
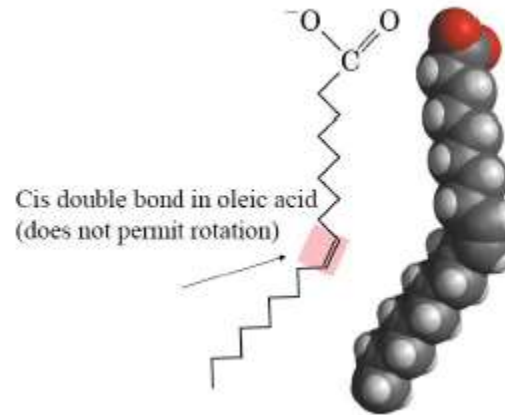
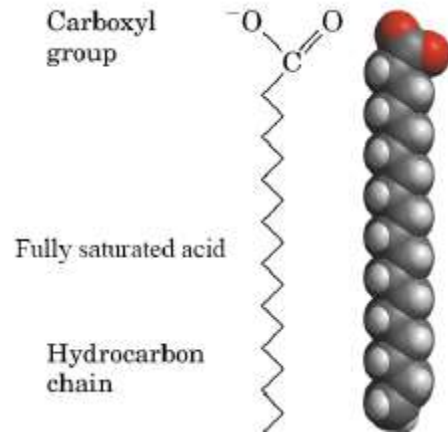
The most commonly occurring fatty acids have even number of carbon atoms in an un-branched chain of 12-24 carbons

PHYSICAL PROPERTIES OF FATTY ACIDS

- The physical properties of fatty acids are largely determined by the length and degree of unsaturation of the hydrocarbon chain.
- The longer the chain and the fewer the double bonds, the lower is the solubility in water, and higher is the melting point.

- Addition of double bonds decreases the melting point whereas, increasing the chain length increases the melting point.
- Trivial names of fatty acids refer to the natural sources of derivation:
 - Palmitic (16:0) -seed fat of palms
 - Oleic (18:1) -seed fat of olive oil.

THE PACKING OF FATTY ACIDS



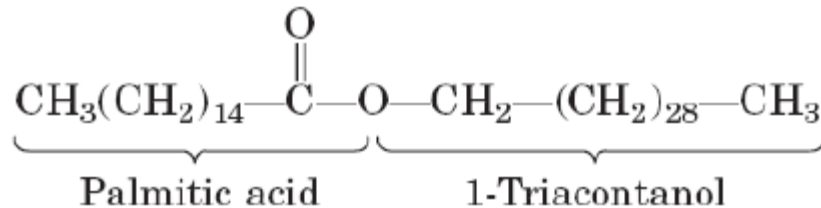
ESSENTIAL FATTY ACIDS

- ◉ Linoleic, Linolenic, and Arachidonic acids.
- ◉ Essential fatty acids synthesize structural fats in tissues such as prostoglandins, leukotriens, prostocyclins, thromboxane which regulate body functions such as blood clotting, inflammation etc.

- Essential fatty acid deficiency can result in abnormalities like poor growth, increase food intake, scale inflammation of skin and impaired immune response.

WAX

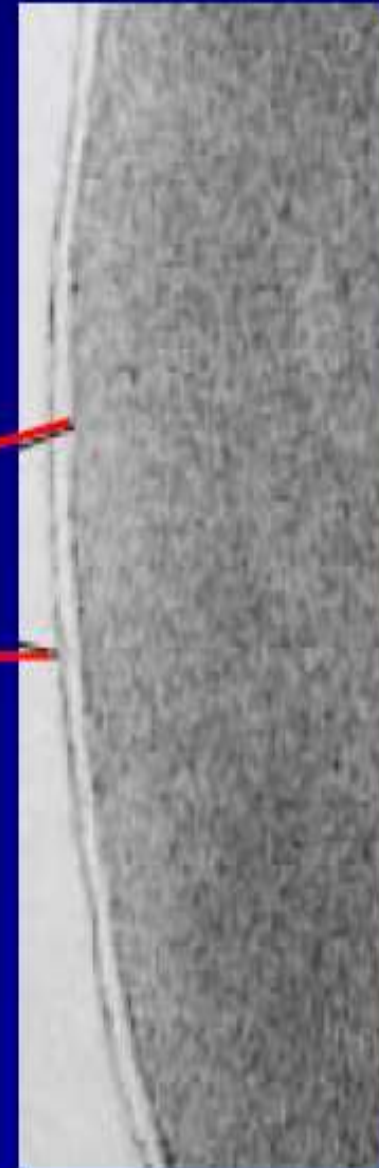
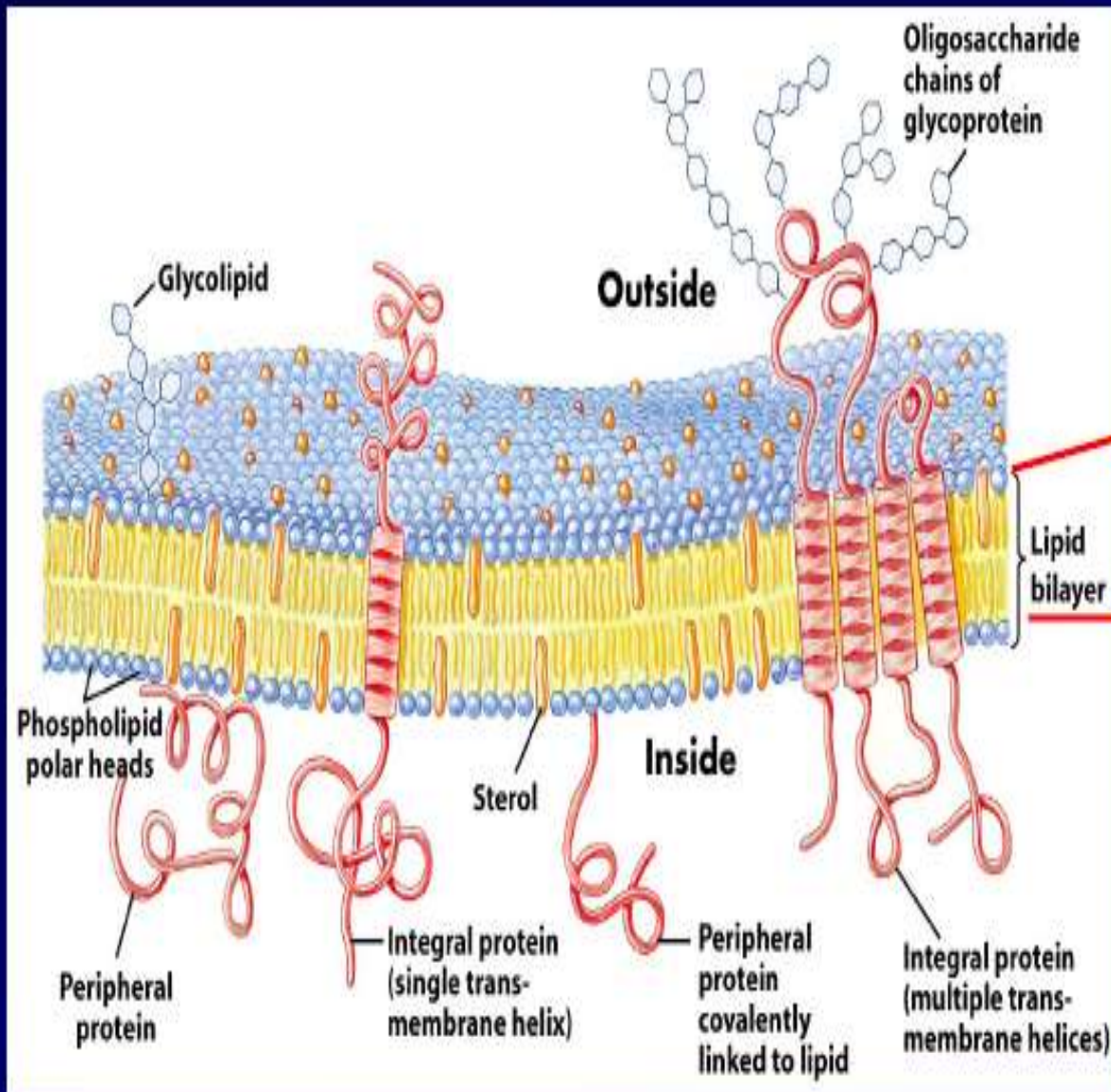
- Waxes are esters of long chain (C14-C36) saturated and unsaturated fatty acids with long chain (C16-C30) alcohols.



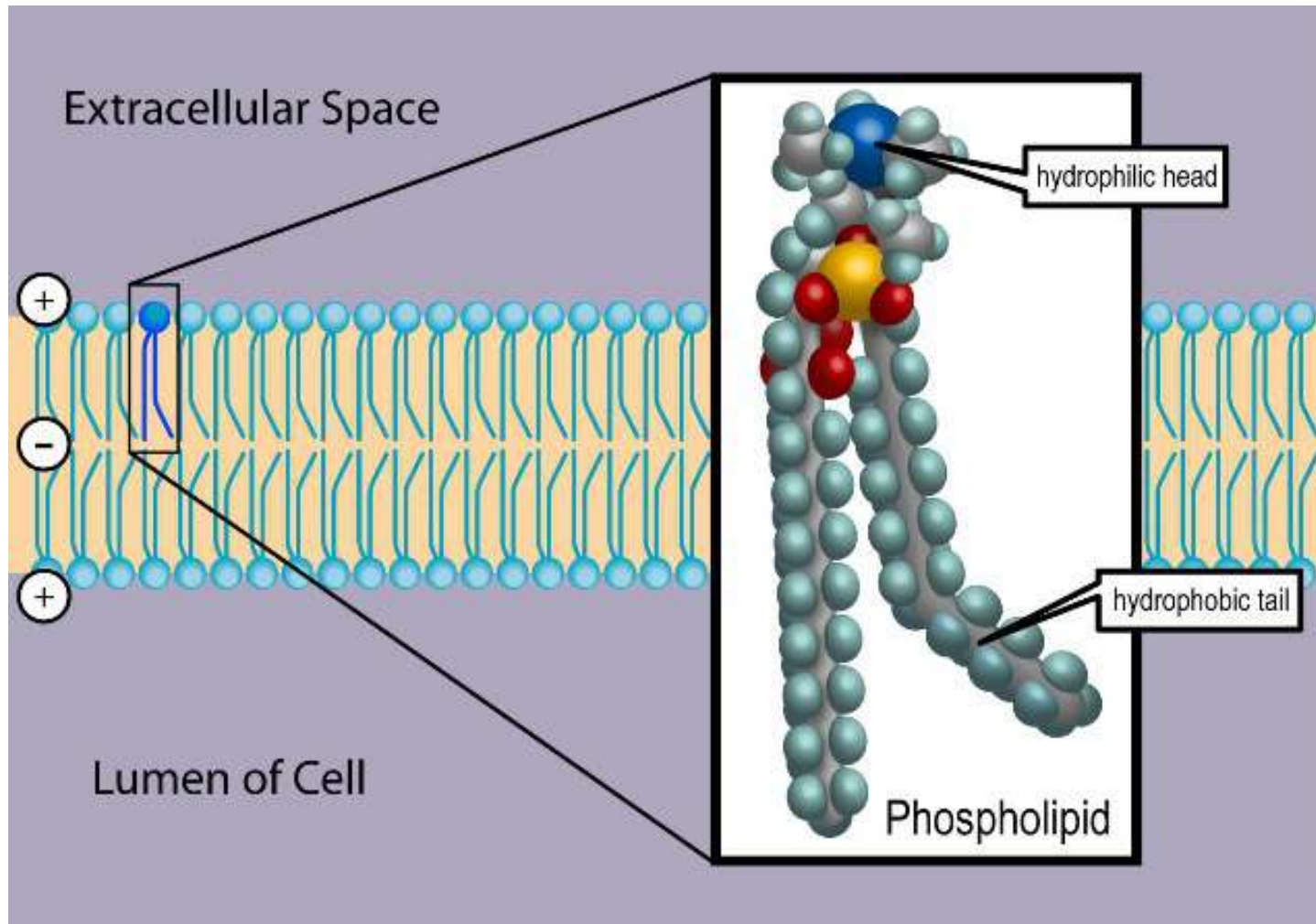
FUNCTIONS OF WAX

- ◉ Chief storage fuels for some of the microorganisms.
- ◉ Protect skin and hair.
- ◉ Prevents excess water evaporation in plants.
- ◉ Protects against parasites
- ◉ Application in industries, pharmaceuticals, and cosmetics

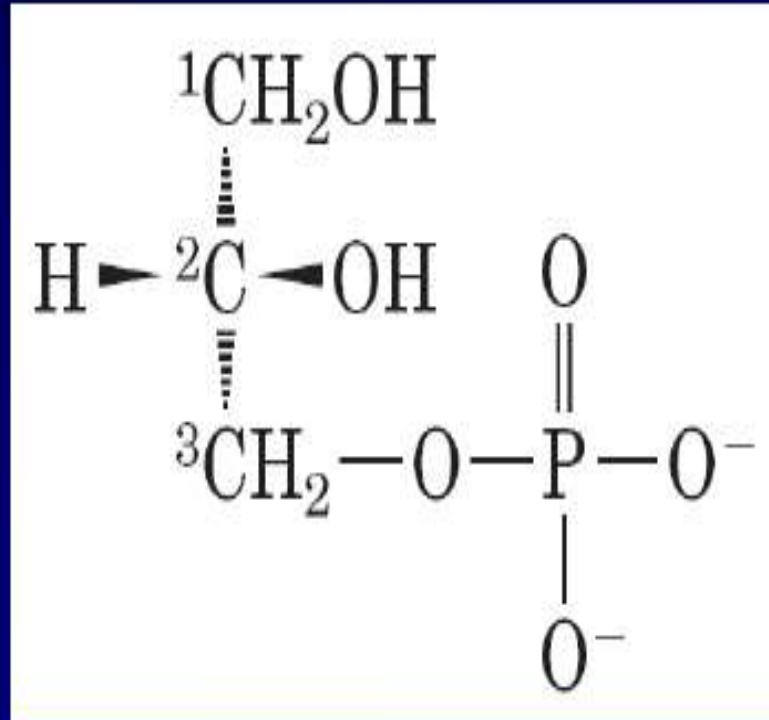
LIPIDS AS STRUCTURAL ELEMENTS



PHOSPHOLIPIDS



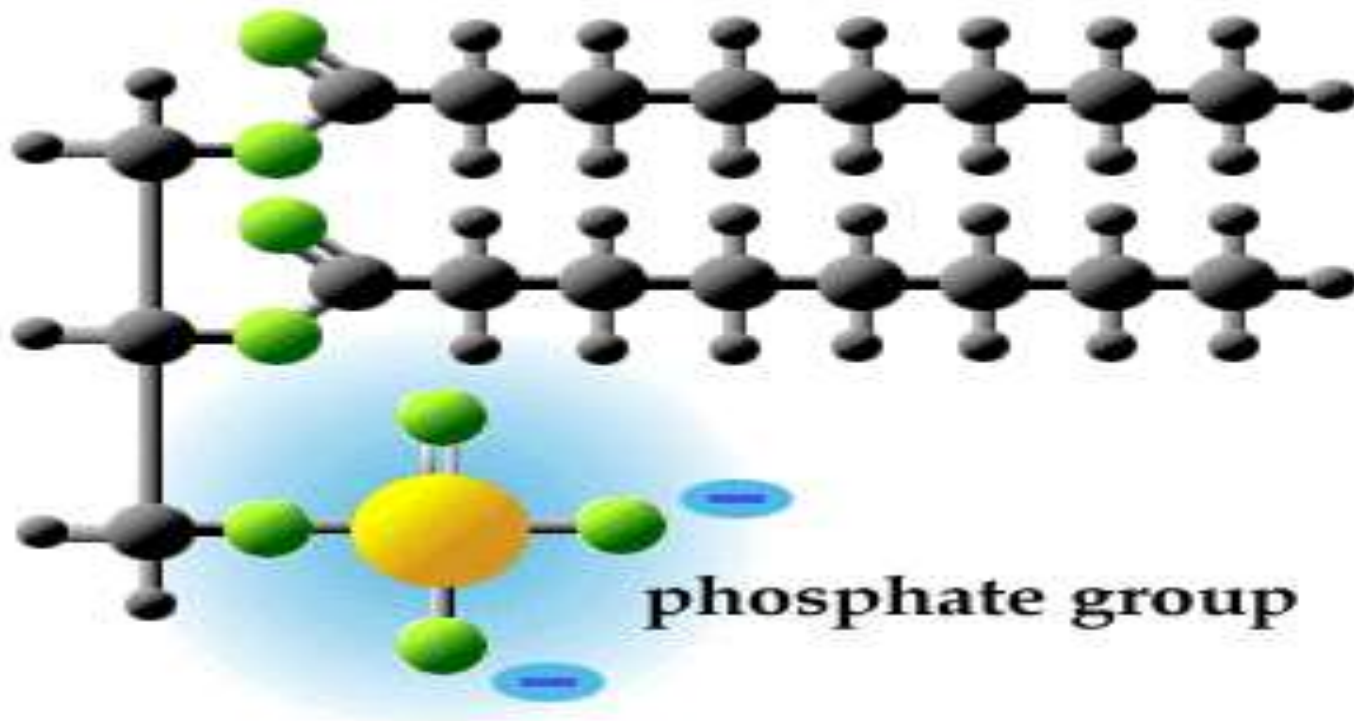
GLYCEROL PHOSPHATE



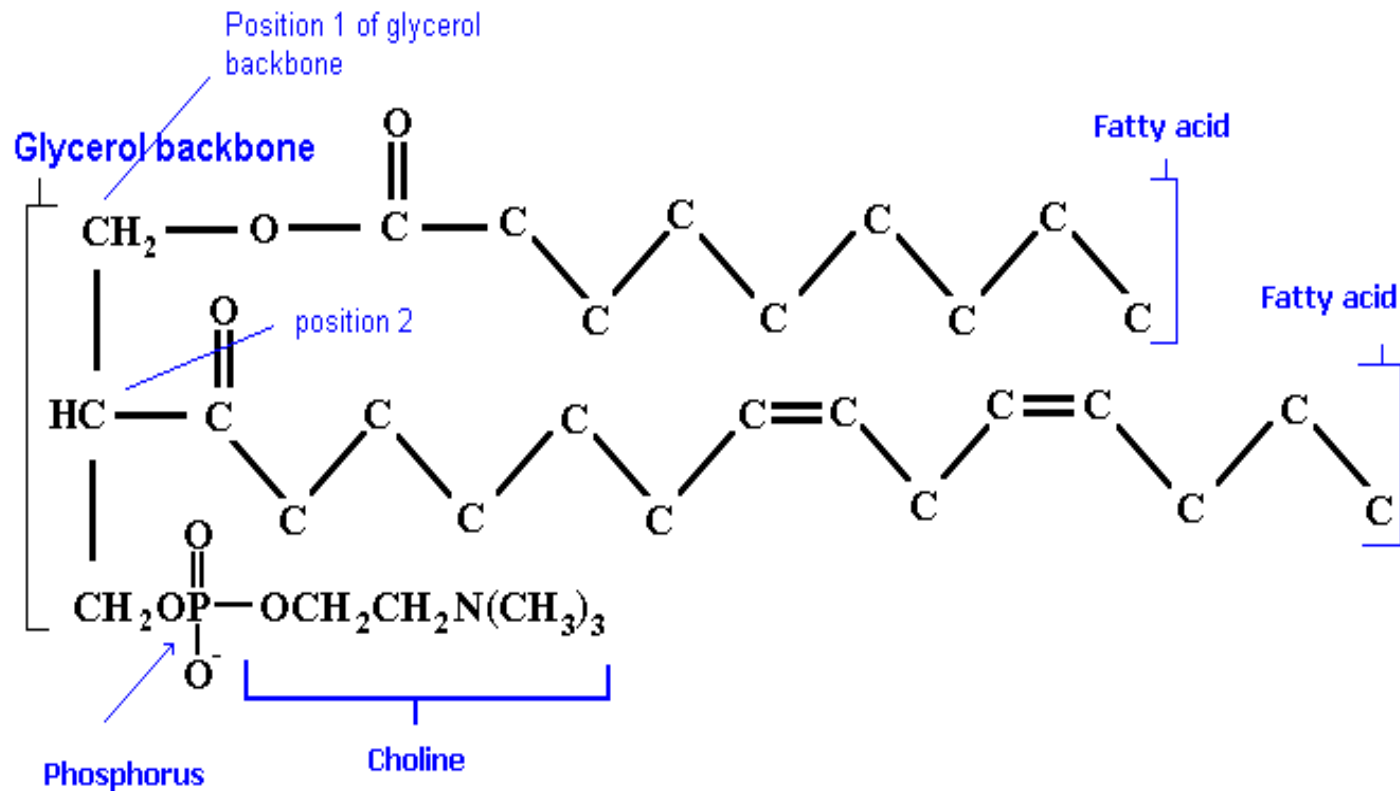
L-glycerol 3-phosphate, is the backbone of glycerophospholipids.

DI-ACYL GLYCEROL-3-PHOSPHATE

Phospholipid

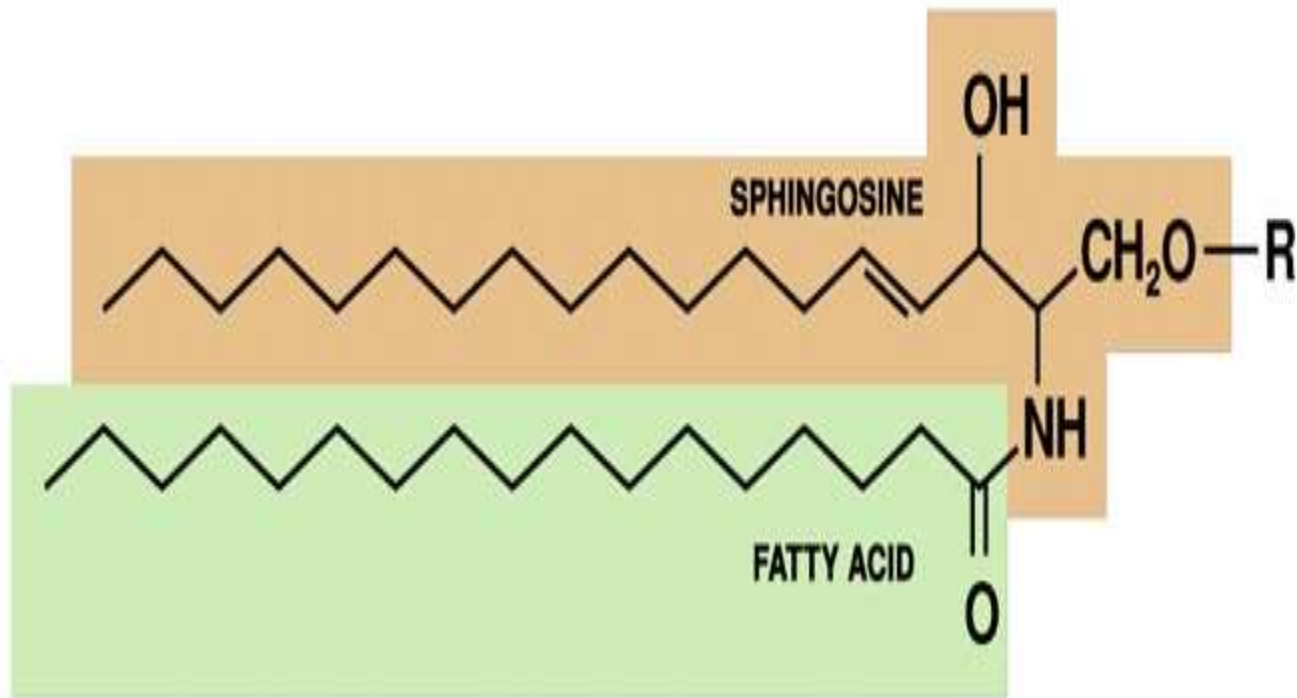


PHOSPHATIDYLCHOLINE



- ⊙ Dipalmitoylphosphatidylcholine = Surfactant

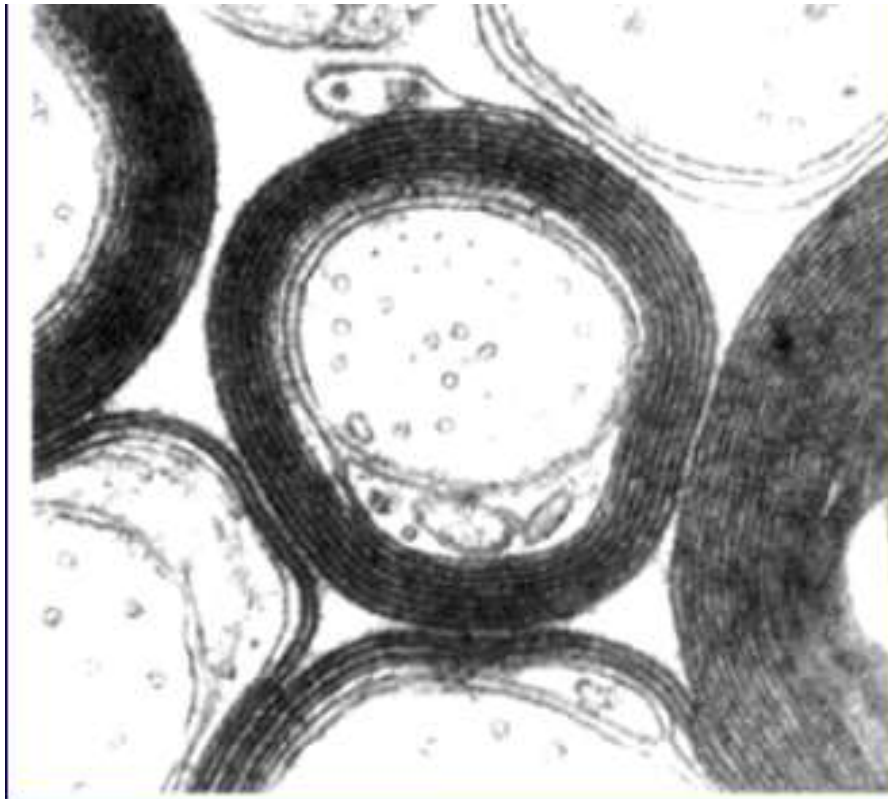
SPHINGOLIPIDS



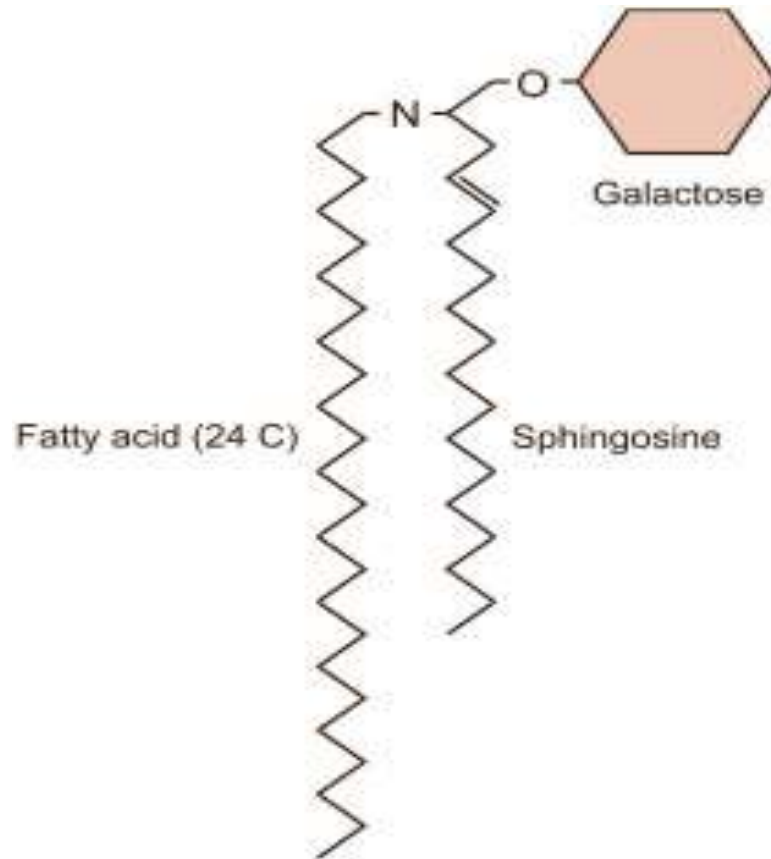
- ⦿ Alcohol is sphingosine

SPHINGOMYELINS

- Sphingomyelins are present in the plasma membrane of animal cells, especially in myelin, a membrane sheath that insulate the axons of some neurons

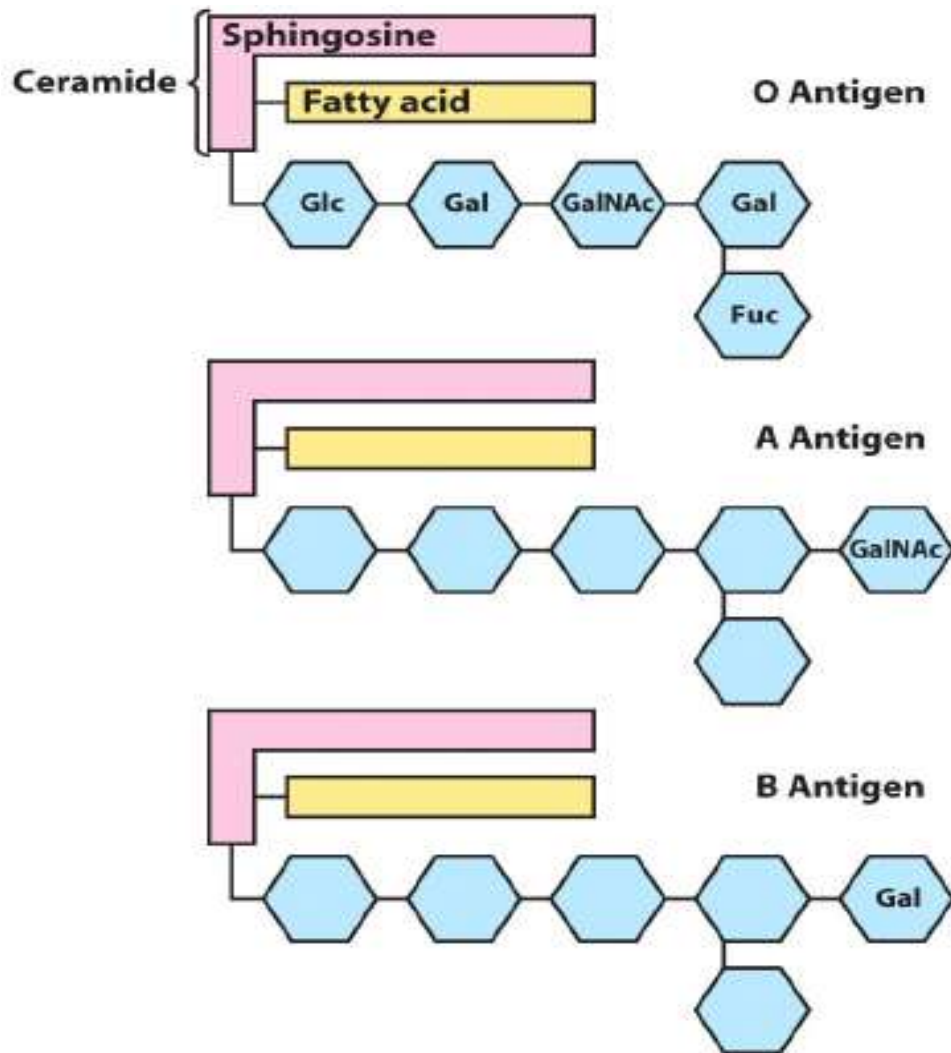


CEREBROSIDES

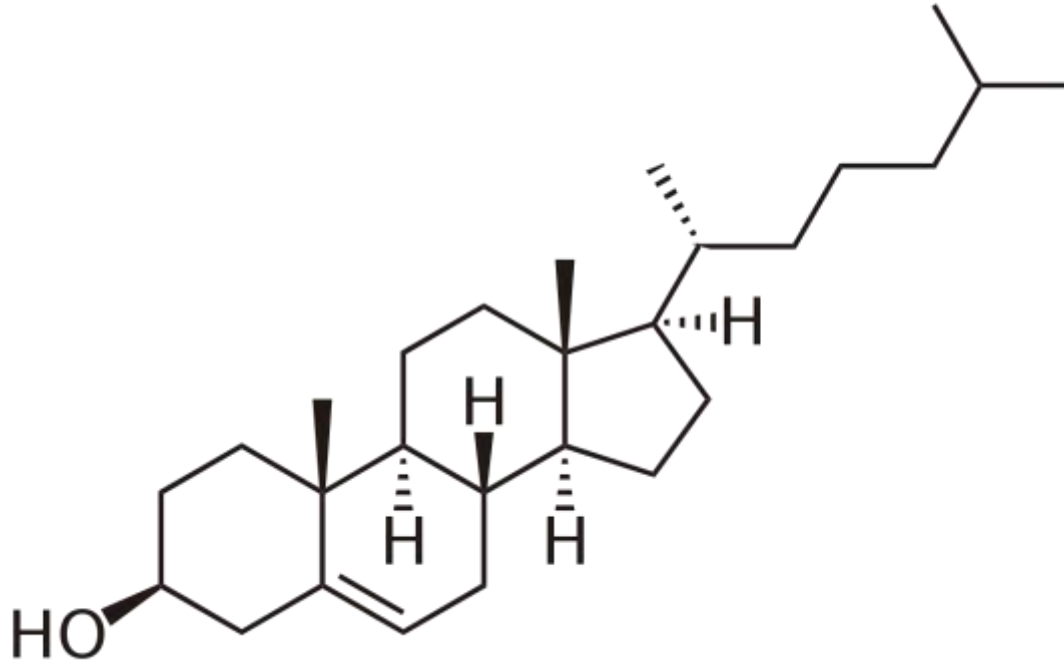


- ◉ Cerebroside + sialic acid = Ganglioside

GANGLIOSIDES AS DETERMINANTS OF BLOOD GROUP



- ◉ Its an essential component of cell membrane



- ◉ Vit. D, hormones and bile acids are synthesised from cholesterol.
- ◉ Bile acids are essential for normal digestion and absorption of fats and fat-soluble vitamins.
- ◉ Most of the cholesterol is synthesised by the liver